This white paper is the first in a five-part series dedicated to examining problems organizations encounter when operating in multimodel environments and the current process improvement approaches such organizations need to consider.

The Value of Harmonizing Multiple Improvement Technologies:

A Process Improvement Professional's View

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About this series

This white paper is the first in a five-part series dedicated to examining problems organizations encounter when operating in multimodel environments and the current process improvement approaches such organizations need to consider. It addresses the benefits of a harmonized approach when implementing more than one improvement model, standard or other technology and provides a high-level description and underlying paradigms of a reasoning framework for technology harmonization.

The rest of this series addresses, in more detail, each phase of the reasoning framework for technology harmonization in a multimodel environment:

- The 2nd white paper examines the approaches needed in technology selection including a strategic taxonomy, the decision authorities associated with that selection at all levels in the organization, and considerations for thoughtful sequencing of implementation in alignment with the organizations' mission, goals and objectives.

- The 3rd white paper examines technology composition in relation to the concepts introduced in the previous white papers; a proposed element classification taxonomy to make technology integration effective in practice; and the role of technology structures, granularity and mappings in technology composition.

- The 4th white paper examines the current state of the practice for defining process architecture in a multimodel environment, methods and techniques used for architecture development, and underlying questions for a research agenda that examines the relationship of technology strategy and composition to process architecture as well as the interoperability and architectural features of different process technologies.

- The 5th white paper addresses the implementation challenges faced by process improvement professionals in multimodel environments, where it becomes necessary to coordinate roles and responsibilities of the champions for different technologies, to integrate and coordinate training, to optimize audits and appraisals, and develop an integrated approach to project portfolio management.
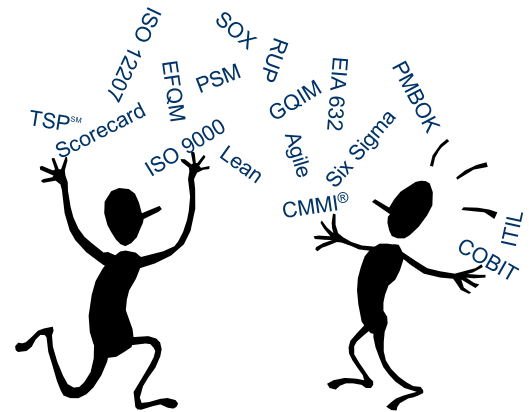
THE VALUE OF MULTIPLE TECHNOLOGIES

Organizational and business process improvement is conducted to support numerous organizational objectives: customer satisfaction, business profitability, market share, product and service quality, cost reduction, cycle time reduction, to name a few. There are numerous reference models, standards and other improvement technologies[1] available to support performance improvement. Some of these are discipline-oriented, while others are discipline-neutral and serve the overall enterprise. Some describe what to do while others are prescriptive about how to do it. Each offers unique features and addresses particular problems; however, they are not mutually exclusive.

Rightfully so, the decision authority for different initiatives rests at different levels in the organization. Accordingly, adoption decisions about enterprise initiatives such as Six Sigma or Lean are made by senior executives, or they may be mandated by governmental policy, as is the case with Sarbanes Oxley and FDA regulations. Functional or business unit level process improvement groups are often charged with the responsibility to select discipline-specific initiatives such as those oriented to establishing organizational processes, such as CMMI® in the systems & software engineering field and ITIL in the IT field. The most tactical of the technologies, such as particular programming methods or requirements management methods for software developers, may be selected by improvement groups or by those responsible for creating products. Each technology carries an implementation cost, including such things as

- providing infrastructure to support the implementation
- tailoring each technology to suit the organizational culture
- developing training
- ensuring compliance
- measuring performance results

It is seldom intentional to implement multiple improvement technologies simultaneously and in an uncoordinated fashion. Technologies are typically adopted one decision at a time, and accumulate over decades from different points within an enterprise and for different reasons. Motivations for each adoption decision vary and include regulatory compliance, the quest for the next perfect solution, or the need to solve a particular product or process issue. A new technology may be added to the collection already in use, or it may be intended as a replacement for legacy technologies. In either case, the addition is often made without coordination and without considering integration or interoperation with other technologies already existing within the organization.

The result of these uncoordinated efforts is an unplanned multimodel reality where several improvement initiatives are concurrently implemented at different hierarchical levels and across different organizational functions, each championing

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[1] In this series of white papers, we use the terms *improvement technologies*, *technologies*, or *models* somewhat interchangeably as shorthand when we are referring in general to the long list of reference models, standards, best practices, regulatory policies and other types of practice-based improvement technologies that an organization may use simultaneously.

those technologies that best address their particular problem space. This multimodel environment leads to perceived and real competition between technologies and their associated improvement initiatives within your organization, which is costly.

When you examine the overall improvement initiative landscape within the organization, redundancies as well as unrealized synergies between competing technologies become apparent. For example, organizations that examine risk management will realize that this capability is included in different ways in numerous technologies.

The consequence of not understanding or managing your organization's overall improvement landscape is to increase the overall cost for, and erode the benefits of, your investments in improving business performance. However, there is a way to realize the benefits and manage the costs; it involves methodically harmonizing the technologies to create a more intentional multimodel process environment.

Voice of the Customer on Challenges

In 2007, participants in the SEPG North America tutorial, *Achieving Success via Multimodel Process Improvement*, were asked

"What is the most significant challenge regarding using more than one technology in the same improvement effort?"

Responses were grouped and analyzed by both frequency of occurrence and rating of importance. The same question was posed to a smaller group at the same tutorial at SEPG Europe and yielded consistent results.

The top seven significant challenges based on *frequency of occurrence* (# of participants with the same response):

1. **Separate improvement technology ownership**, including silo-type and competing infrastructure and factional thinking.
2. **Change management**, including how to prioritize among improvement technologies and how to manage an overwhelming amount of change.
3. **Technical connections** of learning, reconciling, and leveraging the similarities and differences between technologies.
4. **Senior management understanding** of the multimodel challenge and visibility into the operational aspects they need to sponsor.
5. **Training and resources**, including determination of how much of the organization must be proficient in each chosen technology.
6. **Strategy determination**, including setting vision, determining sequence (where efforts are already underway), and implementing in a lean way.
7. **Senior management sponsorship**, including financial support, establishing a mutually beneficial and supporting (rather than competing) infrastructure.

The top seven significant challenges based on *average importance* scores:

1. **Senior management understanding** of the multimodel challenge and visibility into the operational aspects they need to sponsor.
2. **Separate technology ownership**, including silo-type and competing infrastructure and factional thinking.
3. **Project portfolio management**, including too many "#1" priorities.
4. **Technical connections** of learning, reconciling, and leveraging the similarities and differences between technologies.
5. **Change management**, including how to prioritize among technologies and how to manage an overwhelming amount of change.
6. **Senior management sponsorship**, including financial support, establishing a mutually supporting and beneficial (rather than competing) infrastructure.
7. **Communication** between champions, stewards, and change agents promoting or representing each respective technology.

WHAT IS TECHNOLOGY HARMONIZATION IN A MULTIMODEL ENVIRONMENT?

Harmonization is not about creating a master metamodel or a new single technology that encompasses all other technologies. It is not about declaring any single combination of technologies as the best or suggesting a universal combination to suit all. Rather, it is about developing an appropriate solution to meet your individual organizational objectives. To accomplish this harmonization requires understanding and leveraging the properties of the technologies of interest as well as composing these properties and the process architecture into a harmonized solution.

Developing a harmonized solution enables you to

- Determine and understand which technologies will help you achieve the organizational mission.
- Understand both the differentiating and the overlapping features of these technologies.
- Create an organizational process that is focused on the organizational mission and incorporates the features and content of all technologies of choice.

In turn, successfully implementing a harmonized solution results in

- An organizational process architecture that is robust and flexible—one that will not break or require total redesign when new technology features must be incorporated.
- Sustainability of the return on process improvement investment.
- Positioning your organization for future growth, agility, flexibility.

While some common patterns in combining and composing technologies are emerging, each organization needs a harmonized solution that is tailored to its mission and culture. Accordingly, an essential prerequisite for success in multimodel process improvement is a reasoning framework to guide organizations in decision-making and in the development of reusable technology patterns and architectures.

ACHIEVING HARMONIZATION

Our approach to achieving technology harmonization is a reasoning framework. This harmonization approach encompasses relevant principles and practices that result in a vertically aligned set of layers addressing multimodel design and implementation from mission to strategy to tactics to execution. Based on currently available knowledge and research, the key aspects of the reasoning framework to be discussed are

- Alignment of organizational and improvement objectives, including identification candidate improvement technologies
- Strategic categorization of improvement technologies
- Design of your improvement solution including:
  - Technology composition using element classification and other tactical technology connections
  - Process architecture
- Implementation (or execution) of your multimodel process improvement solution, including measurement of results

THE UNDERLYING PROCESS PARADIGM OF THE REASONING FRAMEWORK

Before highlighting each aspect of the reasoning framework, it is important to consider its process underpinnings. Our proposed reasoning framework for harmonization adheres to the paradigm of statistical thinking and relies on an underlying high-level process and a corresponding list of existing and emerging practices that support each process step.

Statistical thinking states that [ASA 01, ASQ 00]

- Everything is a process
- All processes have inherent variability
- Data is used to understand variation and to drive decisions to improve the processes

Figure 1 shows a high-level process underlying harmonization [Siviy 07-1, Siviy 07-2]. For many process improvement professionals this diagram may seem familiar and possibly even intuitive. Nevertheless, it is important to make this process explicit, as it is the structure on which we build our reasoning framework.


Figure 1: High-level process underlying harmonization
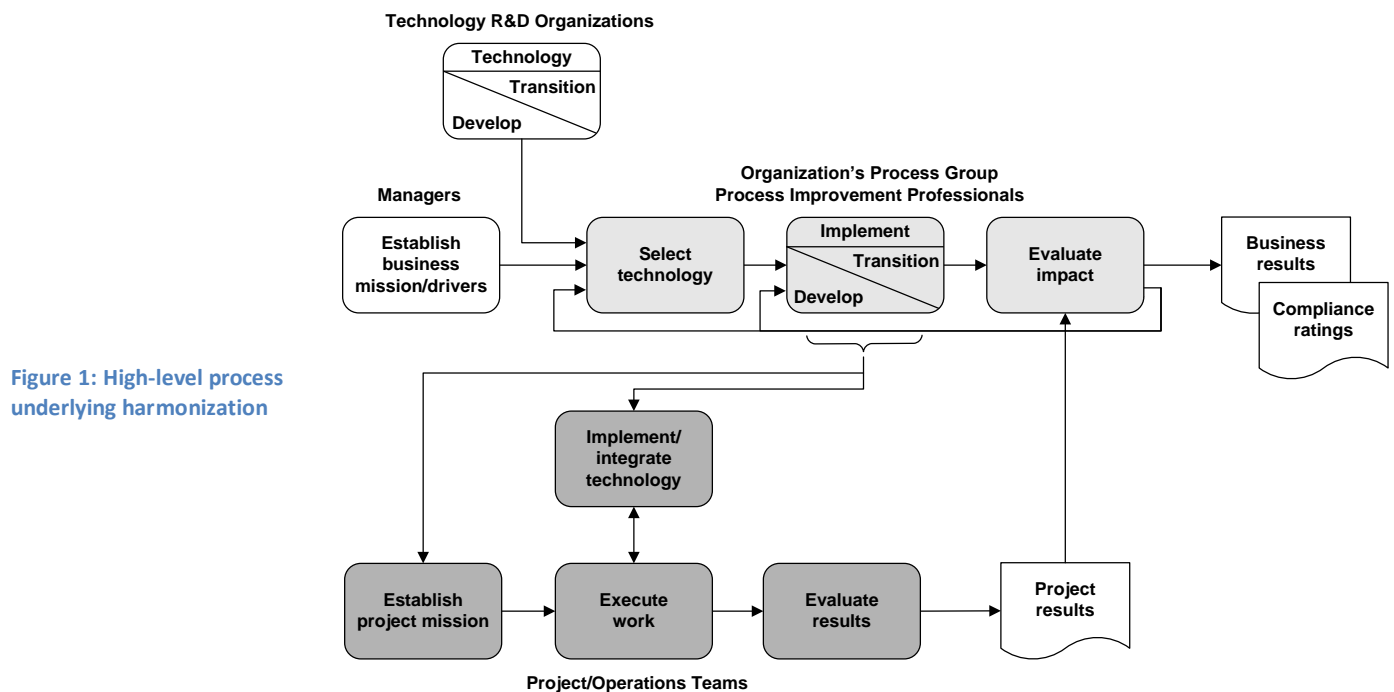
These high-level process steps are annotated by role. The middle row shows that process improvement professionals use business objectives as input to their decision making about which technologies to adopt. In this representation, these technologies are from external organizations. Note, however, that reference practices may also be

internally developed for use within an organization and across the enterprise. Once improvement technologies are selected or internally designed, process improvement professionals then proceed to

- implement by developing (or designing) their particular instantiation of the technology—which may involve tailoring as well as creation of "glue" processes
- transition to their engineers and developers
- evaluate results

These process steps pertain to both the infrastructure implementation and specific improvement projects. To further assist the harmonization effort, we developed guidance questions and best practices to use with these process steps. As such, when the engineering process group uses our steps, questions, and best practices, they become the process engineer rather than just being the vehicle for each new technology rollout [Siviy 07-1].

Guidance Questions

1. What is our mission? What are our goals?

2. Are we achieving our goals? What stands in our way?

3. What process features, capabilities, or performance do we need to support our goals? Which improvement technologies provide or enable these features?

4. How do we combine them into a cohesive internal standard process (new or existing) that we can rapidly and effectively deploy? How do we design an internal standard process that we can easily update as new regulatory or process requirements occur?

   a. How do we deploy our newly designed or updated standard process?

   b. How do we determine the effectiveness of our designed standard process?

5. Once enabling (i.e., infrastructure implementation) projects are under way, how do we manage a portfolio of projects aimed at improving process, project, and product performance?

These guidance questions may seem familiar to the experienced professional; however, many organizations are embarking on this journey without the benefit of past experience. And in the rush to improve, even those with experience may not allow themselves the luxury of stepping back and approaching their efforts in an engineering-like way—rigorously addressing these questions at the onset of their multimodel effort, and as new improvement technologies are considered and thereby fully leveraging available practices and new research.

TECHNOLOGY HARMONIZATION REASONING FRAMEWORK OVERVIEW

Align organizational and improvement objectives and identify candidate technologies

Mission and business drivers should govern the selection of each improvement technology that is adopted within an organization. For this to work, the mission and highest level strategic objectives must be decomposed to operational objectives. Technologies should then be selected based upon their ability to directly provide or indirectly enable process features and capabilities that are needed to achieve mission and operational objectives.

For instance, in Figure 2, the ubiquitous goal of customer satisfaction is decomposed into subordinate goals related to improving an existing IT system, creating a new IT system via "acquisition" (contracting/out-sourcing), and ensuring that the right resources are available to do the work.[2] The improvement group for the IT organization that developed this diagram then proceeded to identify the strategies, tactics, and measures to achieve each goal shown in the diagram. They inherited Lean, which had already been chosen as a governance model by the enterprise but the decision about which improvement technologies to support process establishment was at their discretion. For example, for the goal "Establish acquisition processes" they chose a blend of process maturity models and ISO standards, specifically CMMI, CMMI-ACQ and ISO 12207. Also, the improvement group supplemented their selection of these candidate models and standards with the decision to reuse or extend processes being implemented to support the goal "Stabilize/establish engineering processes". Specifically, they chose processes related to measurement and analysis, requirements development and management, causal analysis, supplier agreement management, decision analysis, risk management, project planning, monitoring, and control, and configuration management. The group decided to use the value stream mapping tool from Lean to finalize their process architecture (guided by the models) and "design in" efficiency and attention to customer value.

Figure 2: Decomposition of high-level goal

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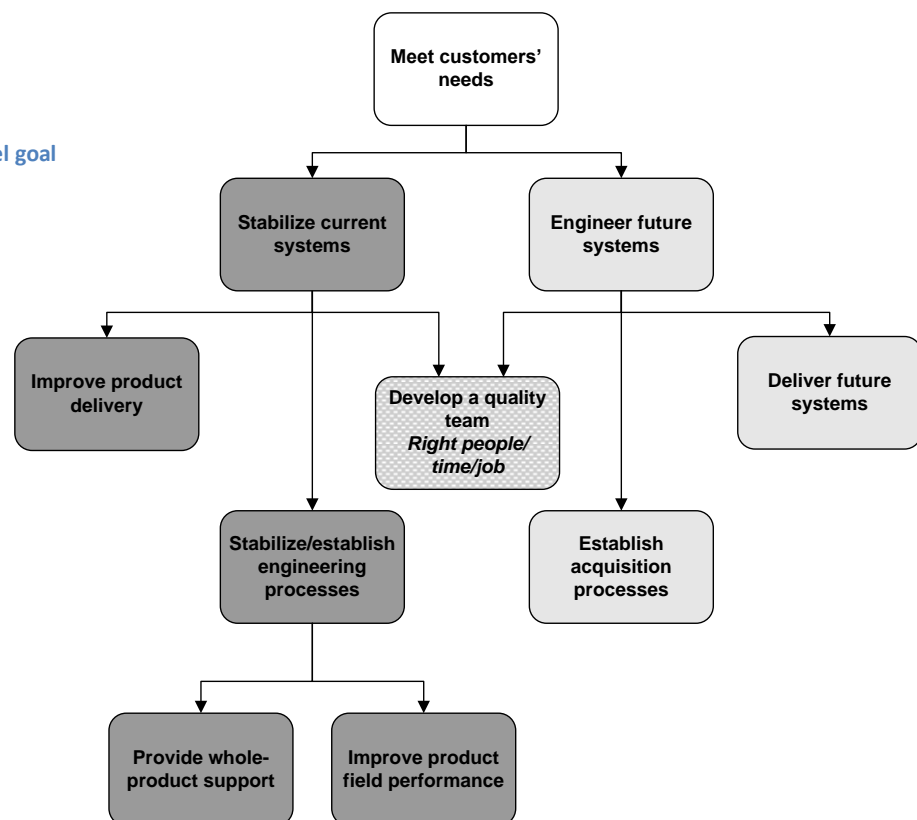
[2] There are numerous, valid decompositions of customer satisfaction goals to operational goals. In this case, the organizational and system situation called for a significant product development focus. In other cases, a set of more traditional cost/schedule/ quality operational goals may be listed. The important thing is to identify those subgoals that are relevant.

Note: For more details on mission translation and alignment of objectives, see CMMI & Six Sigma: Partners in Process Improvement, "Chapter 8.2, Mission Translation and Project Portfolio Management," which is focused on this topic.

Categorize the improvement technologies strategically

In the alignment of technologies to mission each is independently selected (or confirmed) for its potential functional contribution to the organization's objectives. In strategic categorization, each one is examined for its high-level relationship to the other. Additionally, this categorization can be used to refine the list of technologies by identifying gaps and enabling high-level validation and verification. It is important to note that this is not a one-time activity but an iterative process that needs to be performed each time new improvement technologies are considered for inclusion in the organization's process landscape.

To support categorization, we use an affinity matrix, serving as a strategic taxonomy, to distinguish technologies in two dimensions:

- governance, infrastructure, and tactical
- discipline-specific and non-discipline specific

These dimensions are detailed in the 2nd white paper of this series.

Design your improvement solution

Whether implementing technologies singularly or in an integrated approach, some degree of tailoring or customization is typically required to enable the technology(s) for rollout to the organization. For multimodel process improvement, we recommend supplementing strategic categorization with composition of selected improvement technologies and process architecture. These are not necessarily sequential, but may be quite iterative and the starting point may vary. Some organizations may find it most effective to begin with process architecture then back into technology selection and composition. Others may find it most effective to follow the sequence from strategy to tactics.

Compose the improvement technologies tactically and operationally

When it comes to designing your overall improvement solution, understanding the details about how technologies connect with each other is critical. This is a specialized task and represents one of the major contributions improvement groups can make to the process and to improvement integration within their own organizations. Furthermore, this task is one of the major contributors to cost reduction in process improvement as it integrates the output from previously disparate groups, enabling fewer disruptions of projects and operational units during improvement roll-out.

In contrast to strategic categorization, which involves high-level technology relationships to aid selection decisions and alignment, technology composition examines overlapping, distinctive, and enabling functionality among technologies. When considering pairs or small groups of technologies, a "what-how" relationship often emerges. Likewise, detailed feature mappings may be created. Both of these are useful but insufficient, however, simply due to the complexity that occurs as you add more technologies into the mix. To address and reduce this complexity, we are developing a tactical taxonomy called "element classification."

For a more detailed discussion of element classification, refer to the 3rd white paper of this series.

Architect your processes to achieve mission

For the most part, engineers and operational staff do not execute improvement technologies to get their daily work done. Instead they execute the organization's process, including the adaptation made to it as result of the influence of the improvement technologies. It is a big leap from technology composition to process architecture and definition. In fact, we see these as separate but related tasks. Technology composition is not the equivalent of process architecture and process description; both are needed. Process architectures and descriptions are what define the day-to-day operations including how work gets done and products get out the door.

From our research observations, the most successful organizations using multiple improvement technologies created a process architecture and accompanying process descriptions—their corporate way—and then mapped the technologies of interest to it. Their specific mappings served both to verify features and to ensure compliance, where the latter was needed. With this approach, improvement technology implementation was seamless and transparent to the engineers and operational staff. And, the process was rapidly and effectively deployed, and easily updated over time. [Siviy 07-1]

See the 4th white paper of this series for more insights into current practices and research on process architecture.

Implement your multimodel process improvement solution and measure results

Selecting technologies and architecting processes are the design activities for multimodel process improvement. These design activities must then be rolled out to the engineers and developers charged with delivering products. All of the traditional elements of organizational change management apply, including the participation of these stakeholders in the up-front design activities as well as resources, communications, documentation, training, and so forth.

Since these latter items are typically among the core responsibilities of improvement groups, in the context of multimodel process improvement, they face several implementation challenges distinct from singular model improvement:

- Shared/coordinated roles and responsibilities
- Integrated and/or coordinated training
- Coordinated (possibly shared) audit and appraisal processes and data
- Coordinated improvement project portfolio management

These challenges are further discussed in the 5th white paper of this series.

EXPERIENCE SPEAKS VOLUMES

This emerging reasoning framework is constructed, in part, based on SEI research on the CMMI + Six Sigma combination, including investigating Six Sigma as a strategic enabler of CMMI and other improvement technologies [Siviy 07-1] and on specific engagements where we have been asked to assist organizations in their pursuit of a multimodel solution. It also leverages results from SEI work on the other combination as well as relevant non-SEI research publications about improvement method taxonomies and so forth.

We also have researched experience reports from practitioners and emerging solutions from service providers. The following is a sampling of publicly available experience reports from practitioners with successful multimodel solutions that have shaped our thinking:

- **Lockheed Martin IS&GS** has integrated CMMI, EIA 632, ISO 12207, and Six Sigma via its Program Process Standard. Their approach has resulted in accelerated achievement of process and performance uniformity across a geographically dispersed organization. [Siviy 07-1]

- **Northrop Grumman Mission Systems** has integrated CMMI, ISO 9001, AS9100, and Six Sigma, as well as a formal approach to knowledge management. The results have included visible change toward a measurement-oriented culture and accelerated achievement of CMMI goals [Hefner and Sturgeon 02; Hefner and Caccavo 04].

- **Wipro** has an enterprise integrated approach, via its VelociQ system, comprising ISO 9001, CMM, People CMM, TL 9000, British Standard 7799, and Six Sigma. "Six Sigma methodologies brought in quantitative understanding, cost savings, and performance improvement toward product quality" and "brought about a focused customer-centric and data-driven paradigm to product and process quality" [Subramanyam et al. 04].

- **Tata Consultancy Services** has incorporated CMMI, ITIL, ISO 9001, and People CMM into a modular framework called the Integrated Quality Management System. This allows the company to effectively address its business goals for productivity, capacity, agility, reliability, and service [Srivastava 06].

- **University of Pittsburgh Medical Center (UPMC)** is simultaneously engaged in CMMI, Sarbanes-Oxley (SOX), and ITIL. Though UPMC started implementing these separately, it realized that one collaborative effort would be most effective. Through prioritization of processes to implement, alignment of practices across models, and other factors, this center was the first nonprofit medical system in the country to be certified compliant with the most stringent provisions of Sarbanes-Oxley [Carmody and Maher 07].

Each organization has designed and implemented an approach suitable for its organizational culture and business needs. Several have integrated the technologies of choice into a process infrastructure known internally by its organizational name or label, not by the respective name of each technology. In these cases, the software engineers are more likely to assert that they conduct their work using their organization process than they are to say that they use CMMI or another technology. They say this with the confidence that their organizational process infrastructure is compliant with the technologies and standards that are important to the business.

Voice of the Customer on Benefits

In 2007, participants in the SEPG North America tutorial *Achieving Success via Multimodel Process Improvement* were asked

"What is the most significant benefit of using more than one model, standard
or other improvement technology in the same improvement effort?"

Responses were grouped and analyzed by both frequency of occurrence and rating of importance. The same question was posed to a smaller group at the same tutorial at SEPG Europe and yielded consistent results.

The top seven significant benefits based on *frequency of response* (# of participants with the same response):

1. **Holistic, more complete views** provides more flexibility and agility due to the ability to better leverage the differentiating features of each technology, which enables the ability to more comprehensively solve the problems at hand because the solution can more readily draw from multiple sources/references.

2. **Efficient**, due to lessening training needs and implementation effort due to common terminology and not *reinventing the wheel* each time a technology is introduced to the organization.

3. **Synergy**, due to allowing technologies to act as enablers for each other, and to understanding both the overlapping and complementary elements of the technologies.

4. **Acceleration** of the improvement effort and subsequent achievement of bottom line results.

5. **Effective**, because the overall process improvement effort gains credibility from its mission focus, its attentiveness to the needs and priorities of the organization, and the consistency of vision and communications that results from a harmonized effort.

6. **Understanding of the specific connections** between commonly used technology combinations such as CMMI and Six Sigma or CMMI and ITIL.

7. **Measurement** that is more focused on results achieved and that is more easily deployed across all organizational processes because it is better aligned and connected with the improvement effort.

The top seven significant benefits based on *average importance* scores:

1. **Measurement** that is more focused on results achieved and that is more easily deployed across all organizational processes because it is better aligned and connected with the improvement effort.

2. **Understanding of the specific connections** between commonly used improvement technology combinations such as CMMI and Six Sigma or CMMI and ITIL.

3. **Efficient**, due to lessening training needs and implementation effort due to common terminology and not *reinventing the wheel* each time an improvement technology is introduced to the organization.

4. **Synergy**, due to allowing improvement technologies to act as enablers for each other, and to understanding both the overlapping and complementary elements of the technologies.

5. **Enhanced toolset** for improvement that aggregates the best practices available in each improvement technology.

6. **Holistic, more complete views** provides more flexibility and agility due to the ability to better leverage the differentiating features of each improvement technology, which enables the ability to more comprehensively solve the problems at hand because the solution can more readily draw from multiple sources/references.

7. **Acceleration** of the improvement effort and subsequent achievement of bottom line results.

MULTIMODEL HARMONIZATION IS A VALUE-ADDED APPROACH

Conducting process improvement activities in a multimodel environment is today's reality. If not harmonized, such efforts can lead to perceived and real competition between technologies, their associated improvement initiatives, and those change agents championing each. The competition between reference models, standards and other improvement technologies, rooted in an unplanned approach, is costly. Through a reasoning framework for technology harmonization, technologies can be strategically categorized and composed, robust process architectures can be built, and joint implementation (or execution) effectively achieved. The potential benefits, as evidenced by real case studies, warrant the effort.

The tangible and intangible benefits that can be realized by a harmonized multimodel approach include:

- Business focus rather than improvement technology focus
- Cost reduction through economies of scale for all aspects of improvement technology implementation
- Cycle-time reduction for overall improvement efforts and the realization of performance objectives
- Culture change related to establishment of enterprise processes, measurement systems, and more
- Process robustness to an ever-evolving and dynamic world of regulations, as well as models, standards and other improvement technologies
- Long-term, sound, and effective organizational approach to technology selection
- Ability to deal effectively with different structures and terminology of implemented improvement technologies
- Cost reduction in relation to audits and assessments for operational units and projects

Just as there is no single one-size-fits-all solution for process improvement in a multimodel environment (hence the development of a *reasoning framework* for technology harmonization), there is not a single, universal benefit. Each organization will place a priority on a different dimension of value based on its mission, culture, current performance status, and so forth

In the remaining white papers of this series, each aspect of the technology harmonization is explored further.

References

The following are the references used in this white paper. Additional reading materials are listed in the "References" and the "Additional Resources" appendices of CMMI & Six Sigma: Partners in Process Improvement. This listing includes both model-specific references (for CMMI & Six Sigma, as well as other combinations) and multimodel references.

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